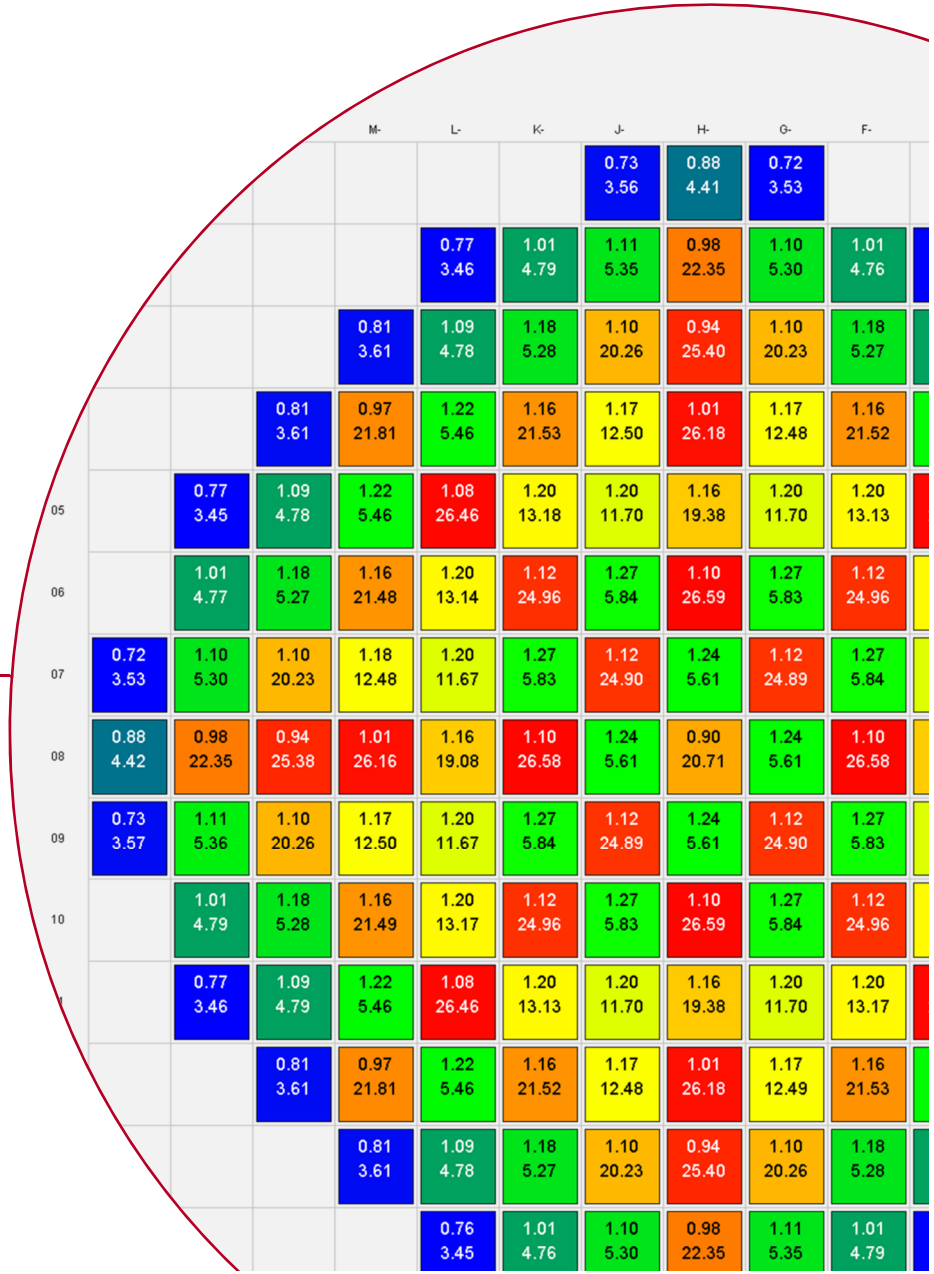
Studsvik

CMSLINK5

Overview

USNRC Pre-Submittal Meeting

April 8th 2015, 8am – 12pm EST

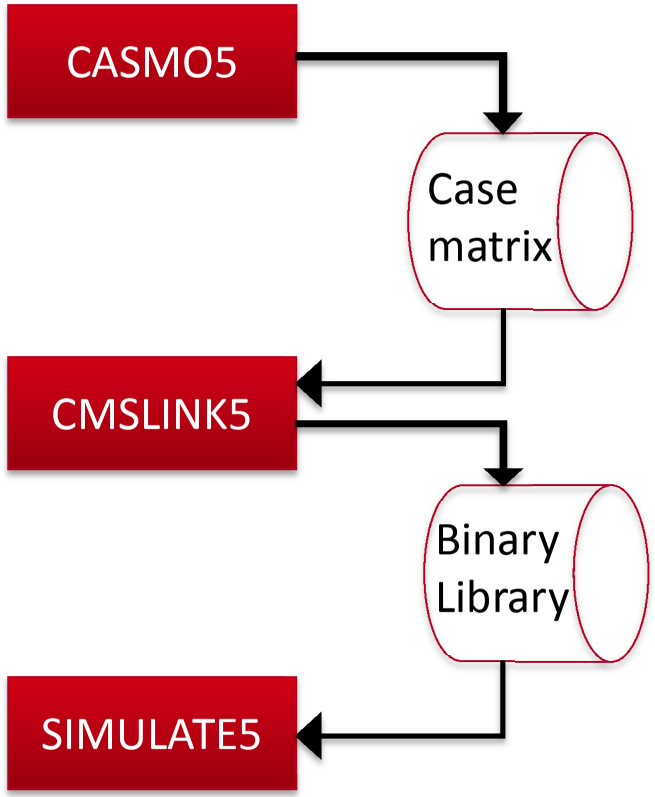


Content

- CMSLINK5 Overview
- Case Matrix
- Cross-section functionalization
- Neutronic Data Types

CMSLINK5 Overview

- A Utility code used in CMS5 to gather and format all CASMO5 data needed in SIMULATE5 and other CMS5 codes.
- CMSLINK5:
  - Reads the CASMO5 data files,
  - Evaluates the depletion and branch cases that are available,
  - Determines the most appropriate multi-dimensional (up to 4-D) table representation,
  - Creates a binary data library that can be read by SIMULATE5



CASMO5 Case Matrix

- ~1500 state points
- Base Depletion (nominal BOR, TMO, TFU, etc.)
- Several history depletions and branch cases, in which one or multiple state point parameter is changed from its base condition.
- Perturbations cover operating range from room temperature to hot
  - Coolant densities = 293K, 393K, 493K, TMO-20K, TMO+20K, Tsat, and VOI = 0, 20, 40, 60, 80
  - Boron concentrations = 0.1, BOR, 2*BOR, 2400
  - Fuel temperatures = 293K, TMO-20, and 1500K
  - Control rod
  - Burnable absorber

Cross-Section Functionalization:

- Instantaneous node averaged conditions
  - Burnup (EXP)
  - Moderator temperature (TMO)/Void (VOI)
  - Fuel temperature (TFU)
  - Boron concentration (BOR)
  - Shutdown cooling time (SDC)
  - Control rod insertion (CRD)
  - Spacer/Grid
- Historical node-averaged conditions:
  - Moderator temperature (HTMO)
  - Fuel temperature (HTFU)
  - Boron concentration (HBOR)

Data Tabulation:

- CMSLINK5 creates 1-D,2-D and 3-D data tables for each of the neutronic data

$$
\begin{aligned}
\Sigma_x = \; & \Sigma_x^{base}(E,\rho_h) + \Delta\Sigma_x^{\rho}(E) \\
& + \Delta\Sigma_x^{BOR}(E,\rho) + \Delta\Sigma_x^{HBOR}(E) \\
& + \Delta\Sigma_x^{TFU}(E,\rho) + \Delta\Sigma_x^{HTFU}(E) \\
& + \Delta\Sigma_x^{CRD}(E,\rho) + \Delta\Sigma_x^{HCRD}(E,CRD) + \Delta\Sigma_x^{BCRD}(E,CRD) \\
& + \Delta\Sigma_x^{NXEN}(E) \\
& + \Delta\Sigma_x^{SPA}(E) + \Delta\Sigma_x^{DET}(E,\rho) + \Delta\Sigma_x^{DGA}(E) \\
& + \Delta\Sigma_x^{SDC}(E) \\
& + \Delta\Sigma_x^{EBP}(E) + \Delta\Sigma_x^{BAP}(E) \\
& + \sum_i \sigma_i(E,\rho_h,\rho,\ldots)(N_i^{actual} - N_i^{SA}(E,\rho_h,\ldots))
\end{aligned}
$$

E: Burnup

ρ,ρ_h: Moderator density/density history

BOR, HBOR: Soluble Boron/Soluble Boron History

TFU/HTFU: Fuel temperature/Fuel Temperature History

CRD/HCRD: Control Rod/Control Rod History

BCRD*: Control Rod depletion

NXEN*: Xenon Number Density

SPA*: Spacer/Grid

DET*: Detector Tube

DGA: Assembly Delta Gap

SDC: Shutdown-Cooling Time

EBP/BAP: Removable Burnable Absorber

(*) New in SIMULATE5 compared to SIMULATE-3

Dependent Data Types:

- Multi-group, assembly homogenized macroscopic cross-sections, discontinuty factors:
  - Average assembly
  - Sub-assembly
- Multi-group, sub-mesh (sub-assembly) homogenized macroscopic cross-section and discontinuity factors.
- Microscopic (absorption, fission) cross sections for 50+ isotopes.
- Assembly average and sub-assembly isotopic number densities for 50+ isotopes
- Two-group pin form factors
- Detector constants
- Kinetics Data (Delayed Neutron Yields/Time Constants, Neutron Velocities)
- Fixed Source Data (Spontaneous Fission Source, Alpha-N Source)

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